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IS THERE A DIRECTION IN ECONOMIC DEVELOPMENT? AND, IF SO, WHAT DOES IT IMPLY FOR EMERGING COUNTRIES?

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1) INTRODUCTION

In this paper we are going to study the implications of two trajectories of long run economic development , the growth in efficiency and the growth in variety/diversity. Here the terms variety and diversity are going to be treated as synonyms although in some circumstances they can differ (Stirling, 2007) In particular, we will concentrate on the growth in variety/diversity. Both of these trajectories imply a directionality in economic development in the sense that the relevant variable keeps increasing the whole time. We will show empirical evidence that the export variety of the countries of the world increased between 1962 and 2000 and that this growth in export variety has been a determinant of their growth of GDP and of GDP per head. Also, we will distinguish related (intra sector) from unrelated (inter sector) export variety and we will show that they play different roles in economic development. This general trajectory is followed by most countries but exceptions can exist at the individual country level. Our results will show that, although long run trajectories constrain the development of every country, such trajectories can be 'interpreted' by individual countries. Thus, individual countries can for limited periods of time deviate from the dominant trajectory and adopt development strategies which follow from their past productive structure and endowments. In other words, economic development is subject to a considerable degree of path dependence. Furthermore, the concept of national innovation system and the asymmetries in output structure and in institutional configurations on which it is based find a justification in our results. This does not mean that individual countries develop in isolation from the rest of the world economic system On the contrary, our results show that in the world economic system there is a permanent tension between forces creating innovations, thus raising system heterogeneity, and diffusive forces, leading to greater homogeneity. In this context long run trajectories, such as those leading to growing efficiency or growing variety, act as common constraints on the countries of the world economic system and each country 'interprets' these common constraints based on its endowments, past output structure and institutional configurations.

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2) VARIETY AND ECONOMIC DEVELOPMENT

2.1) ECONOMIC DEVELOPMENT

Since the industrial revolution the emergence of new technologies and of organisational innovations made a very considerable contribution to the enormous rise in wealth that took place in the following period, thus giving rise to a faster economic growth than at any time in the past. These innovations initially raised the efficiency of a number of functions that had always been carried out by human beings, such as the production of food and clothing or the speed of transport. However, as the development of the economy proceeded powered by the growing efficiency of the new technologies, both production and consumption structures became increasingly diversified. New types of products and services were created and became increasingly differentiated. The overall development path that we can observe was jointly determined by the growth of efficiency and by the growth of creativity. Here efficiency growth is represented by the fall of the ratio of inputs used to produce outputs at a constant output structure whereas creativity is the activity which gives rise to novelty, essentially the result of innovation. As it will be seen later, these two trends are by no means independent. The creation of greater wealth for many people has been obtained by means of profound changes in the production structure of countries, a development which has been accompanied by changing patterns of international trade.

It seems clear that technological change played a very important role in the economic growth which took place since the industrial revolution. Starting from the early innovations in the textile industry, in steam engines, in steel and in railways, a growing number of new products, processes and services became part of the economic system. This aspect of economic development, consists essentially of the creation of new activities giving rise to *qualitative change*, and thus to changes in the composition of the economic system. Qualitative change, which occurs when new entities, qualitatively different from the pre-existing ones emerge, gives rise to discontinuities in knowledge and in production methods. A more common way of describing the same situation is to say that the creation of new activities gives rise to structural change. Structural change is usually measured as the change in the number and relative weights of the sectors constituting an economic system. In a sense qualitative change is a broader phenomenon than structural change when the latter is simply defined as the change in the relative weight of different industrial sectors. Following this definition qualitative change (i) can be present at lower levels of aggregation than sectors and (ii) it refers also to changes in knowledge and in the structure of institutions. Qualitative change takes place at several different levels (Saviotti, 1996). First, new objects are produced; second, generally the activities required to produce the new objects are different to those used for the pre-existing objects, although a one to one correspondence between objects and activities does not exist; third, the institutional infrastructure required for the production and utilisation of the new objects is often different from that required for the old objects. However, if structural change is defined as any change in the structure of the economic system, and if such structure is determined by the components of the system and by their interactions, the two terms coincide. In any case both of them affect the composition of the economic system, defined as the list of entities required to describe the economic system. In what follows we stress that both qualitative and structural change affect the composition of the economic system and thus contribute to economic development.

If economic development has been accompanied, and possibly partly determined by, a growing number of new objects, activities and actors this has not occurred by chance. The creation of these new objects required the previous satisfaction of the basic needs of human beings. For example, nobody would be able to use cars or computers if all their resources were required to purchase enough food to survive. The possibility to produce more refined objects, corresponding to higher needs, required the previous satisfaction of the basic needs of the majority of the population. For example, in the UK at the beginning of the industrial revolution about 60% of the labour force was still employed in agriculture (Hobsbawm, 1968). Furthermore, in the same country during the period 1830-1850 food, housing and clothing accounted for almost 90% of the income of working class families. The income share left free (disposable) from these basic needs only started growing in the second half of the XIX century and to attain 40% of income in the 1950s (ibid. p. 363). Thus, the possibility for most consumers to purchase products and services other than those corresponding to basic needs had to wait until the growing *efficiency* with which the goods and services corresponding to basic needs were supplied increased enough to free a large share of household income. The term efficiency is used here as the ratio of outputs to inputs when the output produced is constant. Efficiency needs to be distinguished from quality and variety. For example, a production process making shoes which during a given period (t_2-t_1) increases its output from 10,000 to 20,000 shoes using a constant quantity of inputs and making the same type of shoes doubles its efficiency. If, however, during the same period the production process changes its output from one to five types of shoes of different qualities it is not clear which increase in efficiency and which increase in quality there has been. The change which occurred is a non easily separable combination of efficiency change and of quality change. Finally, if an economy which produced food, bricks and shoes starts producing also bicycles and radios, its output variety increases. This change in variety is different and distinguishable from both an efficiency change and a quality change. Given that efficiency, quality and variety change, and generally tend to increase, during economic development it is of the utmost importance to find out by what mechanisms these changes come about.

There are, however, few long-term studies on the relation between the composition of national economies and their economic development. Most of the evidence about changes in the composition of the economic systems comes from studies of structural change. Salter (1960) found that the scope for productivity advance differs markedly across industries, mainly due to different rates of technological progress. Industries with high rates of productivity growth were expected to increase their share of output and employment. Structural change would thus be as important a contributor to overall growth as increases in productivity within individual industries. Cornwall (1977) considered that manufacturing was the economy wide engine of economic growth. This would happen because the manufacturing sector displays dynamic scale economies through learning by doing. As production expands the scope for learning and productivity becomes larger. Furthermore, due to its strong backward linkages to other sectors, manufacturing influences, and presumably increases, the rate of output growth and possibly the rates of productivity growth in other sectors. Cornwall's hypothesis was confirmed by empirical work for the years 1950s and 1960s. Of course, Cornwall's hypothesis was likely to hold only during a particular period: in the countries which have a well developed manufacturing sector only changes in the composition of manufacturing (not its presence) or changes in the emergence and composition of services can drive economic development.

More recent empirical work by Fagerberg (2000) and by Fagerberg and Verspagen (2002) confirms the general importance of structural change but points to its changed role with respect to the periods studied by Salter and by Cornwall. For the period 1973-1990 Fagerberg found that the overwhelming part of total productivity growth is accounted for by productivity growth within individual industries. According to Fagerberg this does not necessarily imply that structural change has become unimportant but that its role has changed. In particular, today's leading industries are those related to Information and Communication Technologies (ICT) as opposed to chemicals, electricity, motor cars etc. Advances in productivity growth in ICT could have spilled over to other sectors, thus raising their rates of productivity growth. As a consequence rates of productivity growth might have been wrongly assigned to different sectors. Fagerberg and Verspagen (2002) tested Cornwall's hypothesis for the period after the 1970s. They found that manufacturing still played the role of engine of growth for newly industrialising countries but no longer for industrialised countries. They explained this finding by a type of structural change which was internal to manufacturing itself but which could also cross the boundaries between manufacturing and services. From these studies we can draw the conclusions that a) structural change is an important component of economic development and that b) the use of highly aggregate and infrequently changed industrial classifications is not the ideal way to detect and study the role of qualitative change in economic development.

Another strand of literature emphasises the role of institutions in long-term economic development (North, 1990; Landes, 1998). Observed development patterns are more likely to have been the result of the co-evolution of technologies and institutions than of the simple invention or adoption of superior technologies (Nelson, 1994). Countries which later became leaders could have started by establishing an initial advantage in either technologies or institutions, advantage which led to an improvement in the other co-evolving variable and which in turn gave rise to a feed back positively affecting the initial source of advantage.

It is also evident that the changes in composition of the economic system and the growing wealth that they contributed to create were not uniformly distributed. While the observed pattern of economic development can be described by one or more trends, such as the growth of efficiency or of creativity, these trends were not followed by all the countries in the world economic system. In fact, probably the greatest economic divergence which has been created in human history took place since the industrial revolution. During this period the inter-country distribution of income per head became increasingly skewed (Helpman, 2004). Although economic development is a very complex phenomenon affected by many factors which are not yet completely understood, a link can be clearly established between the structure of the economic system and its capacity to grow in the long run. The increasingly skewed international distribution of income per head since the industrial revolution can be closely related to the differential changes in the productive structure of nations, itself the result of a differential capacity to innovate. At any time since the industrial revolution the most advanced technologies, production techniques and organisational forms were concentrated in a small number of countries which had the highest incomes per head.

Recent evidence about the persistent asymmetry of the international distribution of technological capabilities and the resulting specialisation patterns comes from studies on the dynamics of export patterns (Haussman and Rodrik, 2005; Hidalgo et al., 2007; Saviotti, Frenken ,2008). These studies show how the creation of a capability in a given sector substantially increases the probability of diversifying in related sectors. This dynamics implies that income differences across countries are not necessarily expected to fall and can be quite persistent. It also shows the path dependent nature of economic development at the national level as future opportunities for growth through structural change are conditioned by the existing economic structure inherited from the past. As a consequence of these considerations we can distinguish within economic development long term secular trends (or trajectories), which can in principle be expected to affect equally all countries, and persistent asymmetries, which preserve high degrees of country specificity in both output structure and in the institutional configurations underpinning such structure.

An important distinction to be kept in mind when studying the economic development of different countries is that between short and long run. The types of innovations which are economically effective in the short run are not necessarily the same which would be effective in the long run. New technologies are increasingly created on the basis of previous activities of R&D. In some cases long periods of research are required before the technology becomes profitable. The creation of radically new technologies is likely to require a long period of *exploration* before *exploitation* becomes possible (March, 1991). Thus, the effectiveness of growing variety can be expected to depend on the time horizon taken into account. The impact of such time horizon on the effectiveness of output variety in inducing growth can be assessed by varying the delay between observations of variety and those of the dependent variable used to measure the performance of the economic system. Typically, we can expect very incremental innovations to giving rise to small changes in variety to have a faster pay off than very radical innovations which will create completely new economic species. However, the latter could keep producing profits for a very long time Thus, we can expect an effective innovation strategy to combine innovations which give rise to (i) moderate rises in output variety, economic returns beginning soon but not necessarily lasting for a very long time and (ii) more radical innovations capable of sustaining long run growth but subject to a long and slow take off period.

2.2) VARIETY GROWTH

In the previous sections it was pointed out that very important changes in the composition of the economic system, or equivalently a high degree of structural change, have taken place since the industrial revolution. It is of the utmost importance to decide whether such changes were only an effect of previous economic development or also a determinant of future economic development. If the later hypothesis were to be true it would follow that we need to introduce a representation of structural change into models of economic development and growth. In this paper, as in previous work, we take the view that structural change is a determinant of economic development. In this section we will describe the reasons for which structural change can be considered a determinant of economic development. Furthermore, the results of this paper will provide empirical evidence in favour of such an hypothesis.

In order to integrate structural change into models of economic development we need a variable which allows us to measure its degree. A variable which we can use to represent changes in the composition of the economic system is its variety or diversity. As already pointed out, variety and diversity are not identical. According to Stirling (2007) diversity is the overarching term which can fully represent the growing differentiation of the economic system. Diversity has three components called variety, balance and disparity. Variety is the number of distinguishable economic species within the system, balance the extent of their diffusion and disparity the intrinsic difference between two distinguishable economic species. Variety and balance can be measured while disparity is intrinsically impossible to measure. To measure disparity would be tantamount to fully translate the qualitative differences between any two economic species into a quantitative measure, which is in principle impossible. We can at best hope to assess disparity by means of heuristics or by expert judgement. However, the neglect of disparity would only constitute a serious difficulty if a rise in disparity could lead to a growth in diversity even when variety and balance fall. This discussion exceeds the scope of the present paper. Here it will be assumed that diversity can be adequately approximated by variety and balance. For our purposes variety can be defined as the number of actors, activities and objects required to describe the economic system. It must be pointed out that in this context variety can be used at a higher level of aggregation than the one traditionally used in much of the economic literature on the subject (see for example Dixit and Stiglitz, 1977; Lancaster, 1975). While traditionally variety measured the degree of differentiation of a product group, in the present paper it is used to measure the degree of differentiation of economic systems at different levels of aggregation, starting from a firm or an individual product and ending with the world economy. In this paper then variety is a measure of the extent of differentiation of the economic system as a whole.

There is considerable empirical evidence that the output variety of the most developed economic systems has considerably increased since the time of the industrial revolution. The presence of many new objects, such as airplanes, computers, television sets, etc., of which no analogue was present in previous economic life, and the fact that in general these new objects did not substitute any pre-existing ones, leads to a strong suspicion that the variety of the economic system has grown. Here it must be pointed out that output variety describes the net number of distinguishable objects present in the economic system at a given time. Our data only allow us to measure this type of variety. In fact, we will not even be able to measure output variety for all the countries of the world economic system and we will have to use export variety in its place.

The previous considerations on the process of structural change already point towards the changing composition of the economic system as being a determinant of economic development. A Schumpeterian explanation of economic development (Schumpeter, 1934) would stress the important role which can be played by a country being first to introduce new technologies or organisational forms. It is difficult to justify the investment in new technologies by some countries other than by the expectation that such investment will lead to economic advantage. If variety is also a determinant of future economic development, to design the right composition of an economic system and to create favourable conditions for variety growth become important policy objectives.

The analysis of economic development in terms of variety growth does not deny the importance of efficiency growth. On the contrary, we describe them as long run trajectories and we formulate the following stylized facts and general hypotheses which link efficiency and variety to economic development:

STF1) Economic development is characterised by qualitative change .

STF2) The efficiency of existing processes increases in the course of economic development.

STF3) The diversity/variety of the economic system rises during the process of economic development.

Hypothesis 1: Variety growth is a necessary requirement for long-term economic development.

Hypothesis 2: Variety growth, leading to new sectors, and productivity growth in pre-existing sectors, are *complementary* and not *independent* aspects of economic development.

The two previous hypotheses can be justified by the imbalance between productivity growth and demand growth (Pasinetti, 1981, 1993; Saviotti, 1996; Saviotti and Pyka, 2004). For a closed economy, a continuous increase in productivity with demand reaching a saturation point will cause an imbalance. That such a saturation point can arise was initially pointed out by Engel, who discovered that expenditures on given types of goods and services did not rise as fast as income per head (Engel, 1857; Chai, Moneta, 2008). If the economy were constituted by a constant set of activities, in presence of growing productivity it would become possible to produce all demanded goods and services with a decreasing proportion of the resources used as inputs, including labour. This imbalance would then constitute a bottleneck for economic development as structural unemployment would occur. The addition of new goods and services to the economic system, that is a change in composition leading to a growth in variety, can be a form of compensation for the potential displacement of labour and of other resources. Variety growth is then required for the long term continuation of economic development. On the other hand, new goods and services can only be generated by means of search activities. The resources required for these activities can only

come from the increases in efficiency of pre-existing sectors.
The claims that (i) the variety of economic system has grown, and, (ii) has to grow in order to allow the further development of the system, find a support in the endogenous growth literature. Amongst recent endogenous growth models those by Romer (1990) contribute to the debate about variety by assuming that R&D activities create new types of capital goods which then accumulate in the economy. Although Romer does not use explicitly the concept of variety,in his models at least the variety of capital goods is bound to increase during the process of economic development. This model has also motivated some empirical research testing the relationship between variety and economic growth using employment data (Funke and Ruhwedel, 2001a).

According to the previous considerations, structural change plays a very important role in economic development. If the previous hypotheses 1) and 2) were to be confirmed it would mean that economic development cannot occur without structural change. The best way to test the hypothesis about the role of variety growth in economic development would be to calculate output variety for a group of countries over a long period of time and to test by means of an econometric model the existence of a relationship between some indicators of economic performance and rates of variety growth. Unfortunately the data on national output are not available with the right level of aggregation and with the required degree of comparability. As a consequence in this paper we use data on international trade which are available with the required characteristics. Furthermore, following Frenken et al (2007) we distinguish *related* from *unrelated* variety. These two types of variety refer to the emergence of new products and services (i) similar to those which were already present in the economic system or (ii) completely different and unrelated respectively. It is also possible to interpret related variety as due mainly to *exploitation* activities while unrelated variety would have a greater content of *exploration* activities (March, 1991).

Previous empirical work using different techniques shows that (i) export variety has constantly risen for most countries in the world economic system since the second world war (Bebczuk R. N. , Berrettoni N. D., 2006), (ii) export variety is determinant of the economic performance of countries (Funke and Ruhwedel, 2001a, 2001b, 2005), (iii) in the short run countries need to differentiate their exports but that they have to do it moving to new products and services similar to those which they were previously producing (Hidalgo et al, 2007, Frenken et al 2007; Saviotti, Frenken, 2008, Boschma R,.Iammarino S., 2008). However, when the the time horizon is lengthened more far reaching innovations start paying off (Saviotti, Frenken, 2008). This can be explained by the likely returns which would be encountered by introducing local incremental improvements in the vicinity of the previous products and services. Here the term local must be understood in product and knowledge space. In our paper, as in Frenken et al (2007) and in Saviotti, Frenken (2008), the distinction between related and unrelated variety is fundamental to assess the effectiveness of different types of innovations to export variety and thus to economic growth. In particular, if we define related variety as the type which grows by creating new products and services similar to the previous ones and unrelated variety as the type which grows by creating completely new products and services we can expect related variety to pay off in the short run and unrelated to require longer delays. Studies not including delays, such as Frenken et al (2007) and Boschma, Iammarino (2007) conclude that only related variety has an impact on economic performance. However, Saviotti and Frenken (2008) showed that by introducing delays also unrelated variety becomes a significant determinant of the growth performance of countries.

2.3) SECULAR TRENDS AND NATIONAL INTERPRETATIONS

If all the countries of the world economic system had to follow exactly the same trends in efficiency growth and in variety growth outlined above we could expect complete convergence of their output structures not linked to natural endowments and of the institutional configurations required for those types of output. However,there are reasons to expect that the homogenizing tendencies described by the trajectories in efficiency and variety described above can be counteracted by forces raising or maintaining heterogeneity. The concept of National Innovation System (NSI) (Freeman, 1987; Lundvall, 1992; Edquist 1997, Nelson,1993) emerged based on the observation of persistent asymmetries in (i) output structure and in (ii) institutional configurations. The first of these types of asymmetry was partly due to natural endowments, and thus potentially permanent, except for changes in tastes or for the exhaustion of the natural resources constituting the endowment. However, with the increasing diffusion and the internal differentiation of manufacturing, new competitive advantages were created and added to the given ones based on natural endowments. This transition has been described by the changing theories of international trade (e.g. Krugman, 1979, Soete, 1982). The new sources of competitive advantage were no less durable than the old ones and could persist for very long periods of time. As a consequence, important asymmetries in output structure still exist for most countries (Porter, 1990). Furthermore, even two countries producing the same types of output would never use the same institutional configurations to do it. Bearing in mind that most technologies need complementary institutions to be used widely and that such institutions co-evolve with the technologies (Nelson, 1994, 1995), we can expect that different countries will neither know not be able to imitate one another's institutional configurations

The previous considerations do not imply that countries will develop their own production systems and institutional configurations in complete isolation. In fact, in the world economic system there are both innovations, which are created at particular places and times and raise the heterogeneity of the world economic system, and diffusive forces (trade, technology transfer, etc) which tend to homogenize it. Typically innovations are created in the most advanced countries and in a later phase of the product life cycle (Vernon 1966) they diffuse to less advanced countries. Complete convergence could only be expected to occur if the innovating forces were to cease and diffusive forces were to dominate the system. In presence of both of these forces we can expect steady states reflecting the dynamic balance between innovative and diffusive forces to emerge. Thus, even in a situation in which common constraints affect all the world economic system we can expect individual countries to adapt to such constraints but not to become identical to other countries. The observed asymmetries are the result of the dynamic balance between innovation and diffusion.

The observed growing divergence in income per head and in productive structures during the course of economic development implies that the co-evolution discussed above only took place in some countries. The obvious conclusion is that very little imitation of the leading technologies took place from the industrial revolution to the 1980s. The countries which first introduced important innovations managed to become “Schumpeterian entrepreneurs” which could transform a temporary monopoly into a long range one. As a consequence a productive structure emerged in the world economic system in which a limited number of countries controlled the most advanced productive techniques, and continue to diversify within these techniques, while other countries remained at a substantial distance from the technological frontier of the time.

2.4) IMPLICATIONS FOR DEVELOPING COUNTRIES

If we accept that growing variety is a necessary requirement for long term economic development, in closed as well as in open economies, it follows that the income share of older sectors can be expected to fall gradually in the course of time. We can also expect that, however limited the extent of specialisation of any country, its output variety will be lower than the world output variety at a given time. If world output variety keeps increasing following hypotheses 1 and 2, we can expect that, ceteris paribus, the output variety of countries will also increase. In fact, we can expect the existing output variety of the world economic system to constitute a form of technological frontier which all countries need to try and reach. We can expect the ratio between national an world output variety, eventually corrected for country size, to be a measure of the distance of the country considered from the technological frontier of the time. Furthermore, we can expect that a country will need to keep its ratio of national to world output variety approximately constant if it wishes to conserve its level of income per head relative to the world economic system (Saviotti, 2003). Of course, as in the case of hypotheses 1 and 2, it must be noted that this implication only applies to the long run and to sufficiently high levels of aggregation. In the short to medium run countries can opt for alternative development strategies. For example, a country can specialize in a small number of technologies and output types in which it acquires such a high competitive advantage that it compensates for the reduced ratio of national to world output variety (ibid,). However, such a strategy cannot work indefinitely. Sooner or later a country needs to add new types of output to its existing output structure if all the other countries do so.

3) METHOD, DATA AND RESULTS

3.1) Method

We measure variety using the entropy measure applied to the distribution of sectors in a country's export portfolio, where p_i stands for the share of sector i in total exports of a country. The entropy measure increases with an increase in the number of sectors n and with the evenness of the distribution of shares. Entropy H is computed by:

$$H = \sum_{i=1}^{n} p_i \log_2 \left(\frac{1}{p_i} \right) \qquad (1)$$

The main advantage of the entropy measure over alternative measures, and the reason for its use in the context of studies on variety/diversification, is that entropy can be decomposed at each sectoral digit level. The decomposable nature of entropy implies that variety at several digit levels can enter the same regression analysis without necessarily causing collinearity (Jacquemin and Berry, 1979).

Formally, this decomposition procedure follows from the entropy formula. Let all sectors i at some level of aggregation fall exclusively under a sector S_g at some higher level of aggregation, where $g=1,\ldots,G$. One can derive the shares P_g at the higher level of aggregation by summing the shares p_i at the lower level of aggregation:

$$P_g = \sum_{i \in S_g} p_i \qquad (2)$$

The entropy H_0 at the higher level', also called between-group entropy, is given by the entropy formula:

$$H_0 = \sum_{g=1}^{G} P_g \log_2 \left(\frac{1}{P_g} \right) \qquad (3)$$

The entropy H' at the lower level is given by the weighted average of the within-group entropy values, and is given by:

$$H' = \sum_{g=1}^{G} P_g H_g \qquad (4)$$

with within group entropy:

$$H_g = \sum_{i \in S_g} \frac{p_i}{P_g} \log_2 \left(\frac{1}{p_i / P_g} \right) \qquad (5)$$

This procedure can be replicated at any level of aggregation. Following previous work on related and unrelated diversification, both at the firm level (Jacquemin and Berry, 1979) and at the regional level (Attaran, 1986), we apply the entropy measure at different levels of sectoral aggregation. Our four-digit export data allow for a decomposition at three digit levels. We calculated *unrelated variety (UV)* for each country as the entropy of the one-digit distribution of export shares (*i* standing for one-digit classes). and we calculated *related variety (RV)* as the weighted sum of the entropy at the four-digit level within each three-digit class (*i* standing for four -digit classes and *g* standing for three-digit classes). It can further be shown that entropy at the four-digit level equals the sum of unrelated and of related variety (Theil, 1967; Frenken, 2007), i.e.:

$$H = H_0 + H' \qquad (6)$$

3.2) Data

We used a data set of bilateral trade data by commodity for the period 1962-2000. This data set is based on UN world trade data modified by Feenstra (ref) and it is available from www.nber.org/data (International Trade Data, NBER-UN world trade data). The data are organized by the 4-digit Standard according to the International Trade Classification, revision 2, with country codes similar to the United Nations. The data set allows us to calculate variety in export markets destinations and products. In this paper we exploit only the product dimensions, leaving aside variety in export destinations.

3.3) The econometric Model

We studied the impact of related an of unrelated export variety on the growth performance of the countries of our sample using the rates of growth of GDP and of GDP per capita as dependent variables and by using population, GDP per worker and trade openness as control variables. Furthermore, in order to test the influence of the time horizon on the relative effect of related and unrelated export variety on the countries' growth performance we ran regressions with time lags variable from t-1 to t-10.

Our benchmark model is close to a convergence equation where the rate of growth of GDP between t and t – 1 is a function of initial GDP, of export variety and of a series of control variables, all taken at time t – 1:

$$y_{it} - y_{it-1} = \alpha + \beta_1 y_{it-1} + \delta_1 \ln\left(H^b_{it-1}\right) + \delta_2 \ln\left(H^w_{it-1}\right) + \sum_c \left(\beta_c C_{it-1}\right) + u_{it} \qquad (7)$$

where smaller cases denote the log transform of variables. The dependent variable ($y_{it} - y_{it-1}$) is the rate of growth of GDP of country i at time t, and the terms δ_1 and δ_2 are the parameters of interest, capturing the role of unrelated variety (or between group entropy H^b_{it-1}), and of related variety (or within group entropy H^{w}_{it-1}), respectively. Parameters δ_1 and δ_2 measure the contribution of variety to GDP growth in percentage points. Note the inclusion of y_{it-1}, so that β_1 captures how initial GDP impacts on its future growth rates. Consistently with the convergence literature, we expect β_1 to be significantly negative, suggesting a process of "beta-convergence" between countries. We augment the model with a series of control variables, which are population, GDP per worker and trade openness (defined as exports plus imports divided by GDP), respectively.

Equation (4) can be estimated via ordinary least squares. Moreover we use a two-way error component model in which the error term u_{it} is decomposed into η_i, φ_t and v_{it}, where $\eta_i \sim IID(0,\sigma^2_\eta)$ is a 1×1 scalar constant capturing the individual heterogeneity across countries, $\varphi_t \sim IID(0,\sigma^2_\varphi)$ is a 1×1 scalar constant representing the time fixed effect and $v_{it} \sim IID(0,\sigma^2_v)$ is the individual disturbance: $u_{nt} = \eta_n + \varphi_t + v_{nt}$.

In this paper, we are mainly interested in the lag structure which associates a given state of export variety with future growth rates of GDP. As already mentioned, there are strong reasons to expect that the effect of variety may be more remote in time than what is suggested in Equation (7). This in relation to the distinction between related and unrelated variety, where payoffs for the latter can be expected to occur in a longer time horizon. To take full account of the lag structure between export variety and economic growth, we posit the following finite lag structure:

$$y_{it} - y_{it-1} = \alpha + \beta_1 y_{it-1} + \sum_{\tau=0}^{q_b}\left(\delta_{1\tau}\ln\left(H^{b}_{it-1-\tau}\right)\right) + \sum_{\tau=0}^{q_w}\left(\delta_{2\tau}\ln\left(H^{w}_{it-1-\tau}\right)\right) + \sum_{c}\left(\beta_c C_{it-1}\right) + u_{it} \qquad (8)$$

Equation (8) stipulates that economic growth between any two years is a function of initial conditions at time t – 1, and related and unrelated export variety at time t – 1 – τ, where parameter τ is a integer which belongs to the range (1,…, q). Equation (5) does not restrict the lag length of related and unrelated export variety to be identical. In principle, Equation (8) could be estimated straightforwardly, but the lag structure is likely to yield insignificant parameter estimates due to the high multicollinearity implied by the set of lag variables. A common remedy is to impose a so-called Almon polynomial distributed lag (PDL) structure reducing the number of parameters to be estimated. This approach assumes that the lag weights can be specified by a polynomial as follows:

$$\delta_\tau = \varpi_0 + \varpi_1\tau + \varpi_2\tau^2 + \cdots + \varpi_p\tau^p, \quad \tau = 0,1,2,\ldots,q > p \qquad (9)$$

Usually, a third or fourth order polynomial should provide an accurate approximation of the lag structure. Leaving aside control variables for simplicity, inserting (9) into (8) and rearranging terms yields a modified model where the number of variables is determined by the order of the polynomial:

$$y_{it} - y_{it-1} = \alpha + \beta_1 y_{it-1} + \sum_{p=0}^{P}\left(\delta'_{1p}\varpi_{\tau}^{p}\sum_{\tau=0}^{q_b}\left(\ln\left(H_{it-1-\tau}^{b}\right)\right)\right) + \sum_{p=0}^{P}\left(\delta'_{2p}\sum_{\tau=0}^{q_b}\varpi_{\tau}^{p}\left(\ln\left(H_{it-1-\tau}^{w}\right)\right)\right) + u_{it} \quad (10)$$

Original weights can then be recovered using Equation (9). In the Almon PDL model, both the accurate number of lags (q) and the order of the polynomial (p) are unknown to the observer. Concerning the former, we estimate Equation (8) with 10 initial lags (q = 10) and reduce by one year lag sequentially until q = 0. We then evaluate sequentially the information lost by the omission of a year lag to then choose the number of lags which provides most information. To do this, we use three criteria: the adjusted R-Square, the Akaïke information criterion, the Bayesian Information criterion. Both information criteria must be minimised, whereas the adjusted r-square must be maximised. Concerning the latter, as already noted, the order of the polynomial dictates the number of variables included in Equation (7). A higher order polynomial imposes additional restrictions on the parameter estimates. Hence one can test the accuracy of the polynomial order by performing a standard Log Ratio test.

3.4) Results

Descriptive statistics for all the variables and the Pearson correlation matrix are shown in Tables 1 and 2 in Appendix 1. Table 3 displays the results of the estimations of Equation (7), where all variables have been introduced sequentially. Here we can see that related variety is a significant and stable determinant of GDP growth.

In order to test the robustness of our results we also estimated Equation (7) using GDP per capita as dependent variable. The results are displayed in Table 5. Clearly, both the significance and the magnitude of the effects of all types of variety are very stable. Bearing in mind that these results coincide with those of previous studies using different data sets (OECD, United Nations, national statistics etc) based on both output and export variety, we can conclude that they provide a strong confirmation for the fundamental role played by related export variety in the short run economic performance of countries.

Turning to the estimation of the lag structure, we proceeded by estimation Equation (8) with 10 initial lags and dropping one year lag at a time. We performed the exercise for both unrelated variety (Table 5) and related variety (Table 6), keeping all other variables as in Equation (7). First looking at Table 5, the striking outcome is the lack of consistency between the R-square, the Akaïke and the Bayesian IC's. Whereas the adjusted R-square reaches its maximum value for seven lags, the Akaïke IC is highest for two lags whereas no lag would be recommended by the Bayesian IC. Tables 5 and 6 are displayed in Appendix 1.

Note that ideally, we want to include a sufficiently large number of lags in order to follow overtime the contribution of both related and unrelated variety to economic growth. Moreover, the exclusion of relevant lags would be more detrimental to the estimation than the inclusion of irrelevant lags. Hence our "default" position is to include rather than exclude lags. As a results, we choose to maximize the adjusted R-square and will include seven lags for unrelated variety ($q^b = 7$). Table 6 repeats the exercise for related variety with identical conclusions. Again, we choose to maximize the adjusted R-square and will include seven lags for related variety ($q^w = 7$).

Table 7 displays the core results of the paper, estimating Equation (8) (the unrestricted models) and Equation (7) (the restricted PDL model) using seven lags ($q^b = 7$; $q^w = 7$). Note that we tested for the order of the polynomial, and the results indicate the presence of a significant restriction until the third order polynomial. These results confirm that in the short run only REV is a significant and positive determinant of the growth performance of countries while UEV makes a negative contribution to growth. The situation changes and the roles of UEV and of REV are reversed if we gradually increase the lag from 1 to 7 years. For a lag of 4 or 5 years UEV becomes significant and positive and REV becomes significant and negative. In Fig 1, which represents the influence of the lags on REV and UEV, we can see that the coefficient of REV turns from positive to negative and that of UEV turns from negative to positive when the lag rises from 1 to 5. The results for lags greater than 5 years are not meaningful.

Table 3. Dependent Variable: Real GDP growth rate

Least Square Within Regressions[a]

	(1)	(2)	(3)	(4)	(5)
Real GDP (log)	-0.046***	-0.056***	-0.057***	-0.057***	-0.049***
	[0.004]	[0.005]	[0.005]	[0.005]	[3.20]
Overall variety (logs)		0.008***			
		[0.002]			
Unrelated variety (logs)			-0.019*	-0.019**	-0.032***
			[0.010]	[0.010]	[3.12]
Related variety (logs)			0.023***	0.019**	0.028***
			[0.008]	[0.008]	[3.40]
Openness				0.032***	0.031***
				[0.004]	[7.22]
Real GDP per worker					-0.008
					[0.52]
Population (logs)					-0.007
					[0.47]
Constant	0.854***	1.062***	1.087***	0.933***	0.931***
	[0.080]	[0.094]	[0.095]	[0.096]	[7.59]
Observations	4113	4113	4113	4113	3946
Number of Country	134	134	134	134	131
R-squared	0.07	0.07	0.08	0.09	0.09

[a] All regressions include a full vector of year dummies.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. Dependent Variable: Real GDP per capita growth rate
Least Square Within Regressions[a]

	(6)	(7)	(8)	(9)	(10)
Real GDP per capita (log)	-0.034***	-0.045***	-0.045***	-0.045***	-0.036**
	[0.004]	[0.005]	[0.005]	[0.005]	[2.40]
Overall variety (logs)		0.009***			
		[0.002]			
Unrelated variety (logs)			-0.013	-0.013	-0.034***
			[0.010]	[0.010]	[3.35]
Related variety (logs)			0.018**	0.015*	0.031***
			[0.008]	[0.008]	[3.71]
Openness				0.031***	0.031***
				[0.004]	[7.14]
Real GDP per worker					-0.018
					[1.22]
Population (logs)					-0.052***
					[5.15]
Constant	0.304***	0.436***	0.447***	0.298***	0.871***
	[0.035]	[0.047]	[0.048]	[0.053]	[7.16]
Observations	4113	4113	4113	4113	3946
Number of Country	134	134	134	134	131
R-squared	0.06	0.06	0.07	0.08	0.08

[a] See previous table footnotes.

Table 7. Dependent Variable: Real GDP growth rate
Least Square Within Regressions[a]

	Unrestricted Model (31)		Restricted PDL (32)	
Real GDP (log)	-0.088*** [0.019]		-0.087*** [0.019]	
Openness	0.033*** [0.005]		0.034*** [0.005]	
Constant	1.295*** [0.162]		1.286*** [0.162]	
	Unrel. Variety	Related Variety	Unrel. Variety	Related Variety
t - 0	-0.053*** [0.020]	0.066*** [0.017]	-0.055*** [0.019]	0.063*** [0.017]
t – 1	0.016 [0.024]	-0.025 [0.021]	-0.039*** [0.009]	0.032*** [0.008]
t – 2	0.019 [0.024]	-0.035* [0.021]	-0.017** [0.007]	0.008 [0.006]
t – 3	-0.041* [0.024]	0.040* [0.021]	0.004 [0.006]	-0.008* [0.005]
t – 4	0.039 [0.024]	-0.027 [0.021]	0.018** [0.008]	-0.015** [0.006]
t – 5	0.000 [0.024]	-0.002 [0.020]	0.021** [0.009]	-0.013 [0.008]
t – 6	0.038 [0.023]	-0.027 [0.020]	0.006 [0.007]	0.000 [0.006]
t – 7	-0.050*** [0.019]	0.041** [0.016]	-0.033** [0.015]	0.025* [0.013]
Long run elasticities	-0.031* [0.016]	0.029** [0.013]	-0.095*** [0.025]	0.092*** [0.023]
Observations	3,165		3,165	
Adjusted R^2	0.053		0.051	
Testing polynomial degree (Chi-square statistics)				
5 to 4			0.71	
4 to 3			5.69*	
3 to 2			14.40***	
2 to 1			17.72***	

[a] See previous table footnotes. Real GDP per worker and population also included but not reported, due to lack of significance.

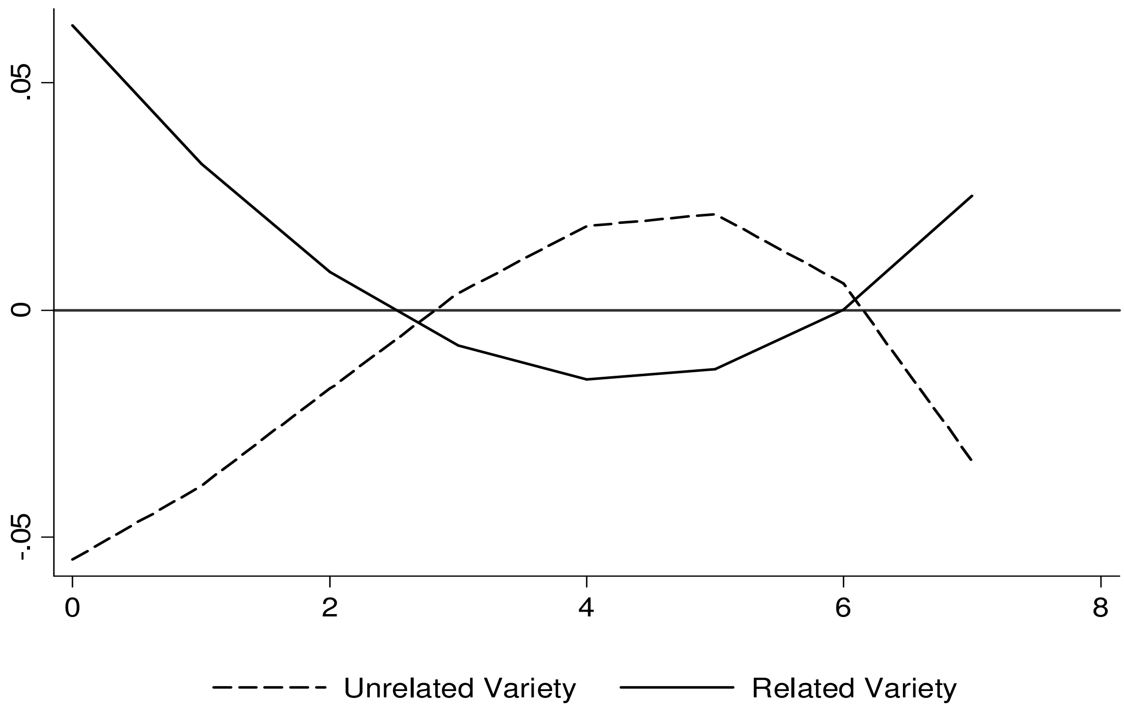

Figure 1. Estimated lag structure of the PDL model for both related and unrelated variety.

The previous results provide empirical evidence for the existence of a trajectory in economic development leading to variety growth. However, the the existence of such a trajectory does not imply that all countries follow it exactly at all times. Figs 2-6 show the evolution of REV, UEV and of total export variety during the period studied. From these figures we can see that although the prevalent trend is towards growing export variety there are countries which during the whole period or parts of it show a fall in export variety. For example, Argentina shows a steadily falling export variety during the whole period 1962-2000 while Brasil and Chile show almost opposite trends in declining and rising export variety. Unsurprisingly the most spectacular performance is displayed by Asian countries.

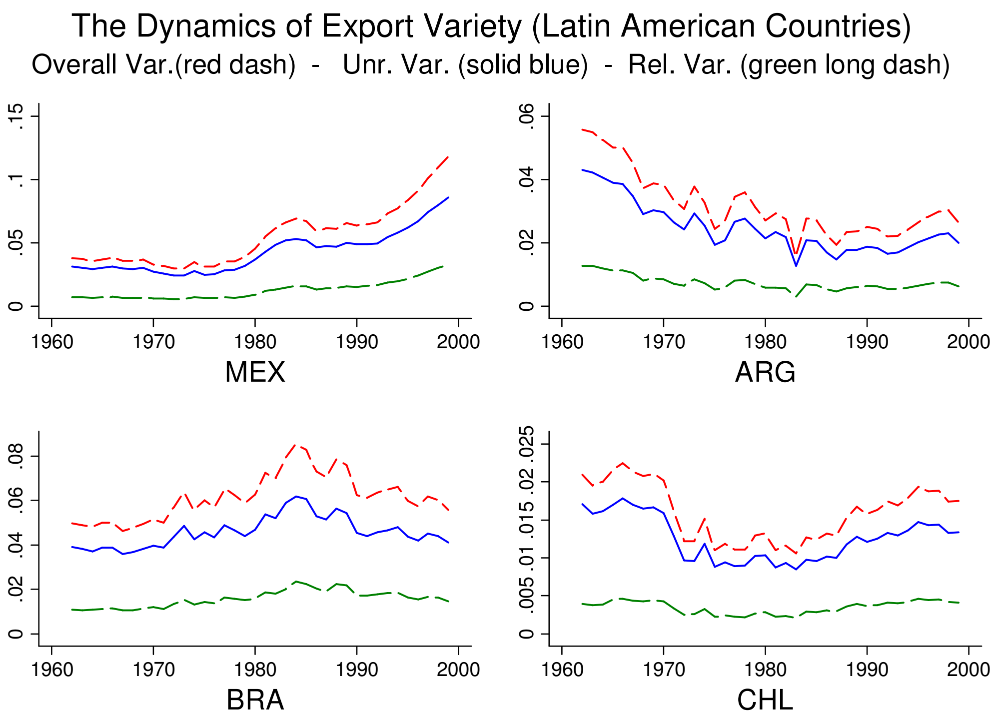

Fig 2. Export variety of Latin American countries

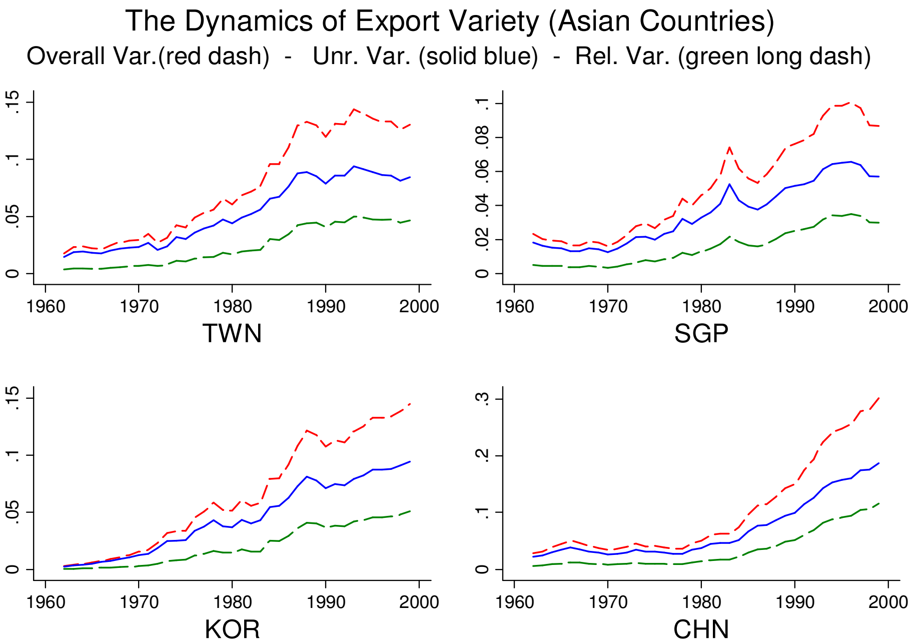

Fig 3. Export variety of Asian countries

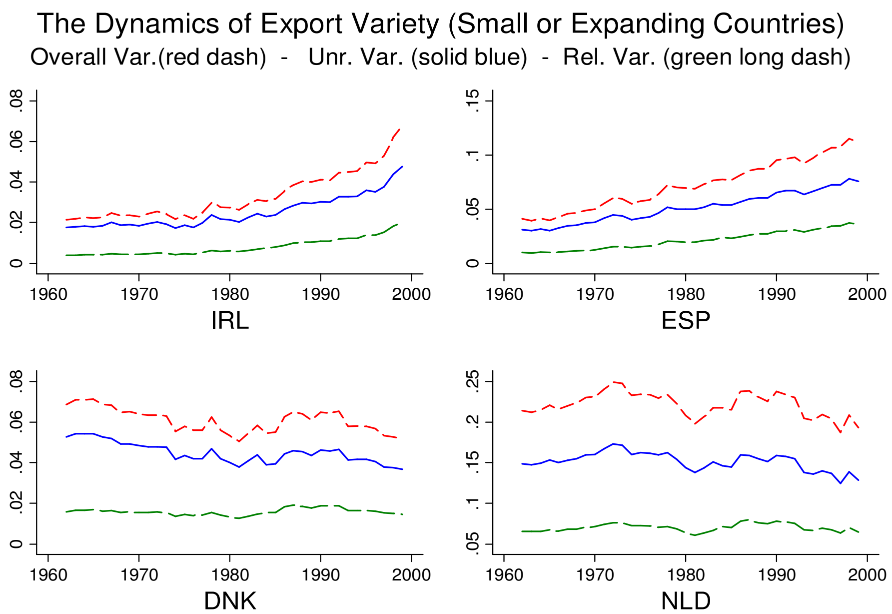

Fig 4. Export variety of small or expanding countries

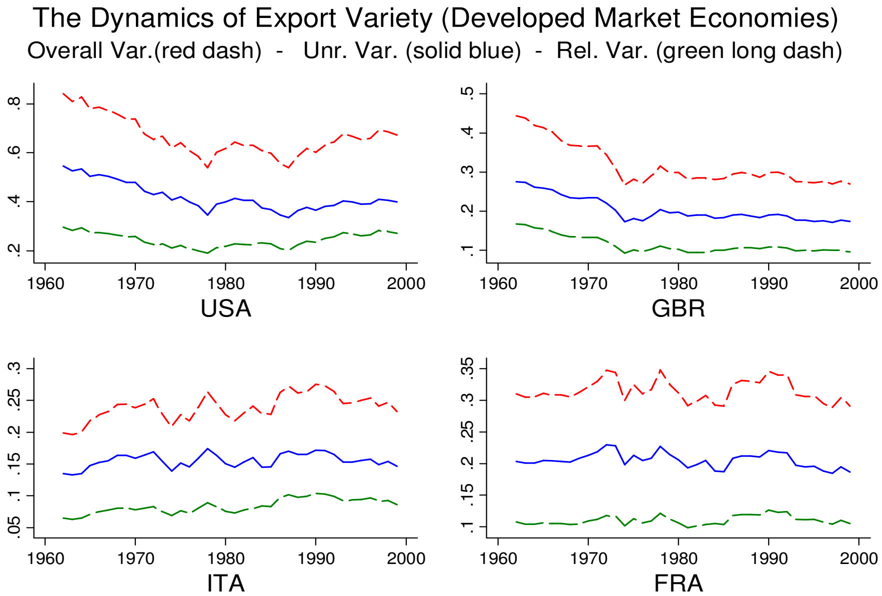

Fig 5. Export variety of developed market economies

4) CONCLUSIONS

The results presented in this paper confirm those of previous empirical work (Funke, Ruhwedel, 2001a;2001b, 2005, Frenken et al 2007; Bebczuk , Berrettoni., 2006, Boschma Iammarino, 2008; Saviotti, Frenken , 2008) according to which economic development is accompanied by growing variety. For reasons of data availability it was not possible to test the growth of output variety and export variety was used in its place. Although export variety is not a substitute for output variety in general we do not expect the former to rise without arise in the latter. Our data do not allow us to exclude the possibility that some countries imported and then re-exported the same product. However, we doubt that such an activity could have been the basis for the general process of economic development for all or most countries of the world.

Our results show that REV is a significant determinant of the growth performance of countries while UEV becomes a significant determinant in the long run. These findings can be explained if we assume that in general innovations follow a life cycle in which they are created by search activities which give broadly define new technologies and lead them to a threshold beyond which they become profitable. During the innovation life cycle the emphasis shifts from exploration to exploitation activities (March 1991) and the type of innovation from radical to local and incremental. The dominance of REV in the short run corresponds to the period in which local and incremental innovations based mostly on exploitation raise export variety and provide a fast pay off. On the other hand, the significance of UEV corresponds to the need to introduce innovations demanding a greater creative effort and a higher dose of exploration activities. The lags corresponding to the significance REV and of UEV cannot be interpreted as a measures of the period required for the creation of an innovation. The initial part of the life cycle of a innovation, characterized uniquely by search activities (R&D etc) and not giving rise to any economic returns. is obviously not covered by our data. Export data describe actual sales and can only represent products with different degrees of maturity. and requiring different degrees of creativity. Our results can then be interpreted by saying that countries need to differentiate their exports in order to grow but that they can only do it profitably if by moving in small steps in a product and knowledge space. (Hidalgo t al 2007). The most effective development path combines the short run performance obtained by differentiating in the vicinity of previous products and services ad the long run performance which is prepared by creating suitable additions to the present range of exports.

The above trajectory applies to the world economic system but exceptions can exist at the individual country level especially for short periods of time. In the short run a country can specialise in a limited set of sectors in which it becomes so competitive as to compensate for the absence of other sectors. However, it will be impossible for any country to keep its export variety constant indefinitely while world output and export variety keep growing.

At any time the state of the world economic system is likely to be determined by a trade off between the rate of creation of innovations, which are unevenly distributed, and diffusive forces leading to technology transfer and imitation and tending to homogenize the system. Even leaving aside the natural endowments, we could not expect complete convergence of the countries of the world unless the rate of innovation fell to zero or became much lower than the rate of diffusion. Excluding these extreme possibilities which do not seem to very likely in the present situation of the world economy, we can expect that in the foreseeable future the trajectory leading to variety growth will be a common constraint to which all countries will have to adapt. However, individual countries will have the possibility to 'interpret' this common constraint based on their endowments, productive structures and institutional configurations. Even in presence of globalization we cannot expect the asymmetries in output structures and in institutional configurations observed in the past to disappear. Both long run trajectories providing specific directions to economic development and national innovation systems jointly affect world development.

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APPENDIX

Table 1. Descriptive Statistics[a]

Variable	Obs	Mean	Std. Dev.	Min	Max
Real GDP[b]	4,261	1.86×10^{8}	6.01×10^{8}	173745.3	8.77×10^{9}
Real GDP per capita	4,264	4,251.6	5,433.6	114.0	33,725.8
Real GDP growth rate	4,113	0.037	0.063	-0.734	0.603
Real GDP per capita growth rate	4,113	0.018	0.062	-0.543	0.575
Openness[c]	4,264	63.4	43.0	4.9	439.0
Real GDP per worker	4,089	14,556.2	13,109.3	574.8	62,459.4
Population[d]	4,264	35,142.7	117,801.5	40.8	1,249,982.0
Overall variety	4,951	0.036	0.088	0.000	0.840
Unrelated variety	4,951	0.025	0.056	0.000	0.545
Related variety	4,951	0.011	0.032	0.000	0.295

[a] Data sources: Penn Tables (Heston, et al., 2006) and World Trade Data (CITE)
[b] Expressed in thousands of 2000 US dollars. Computed as Real GDP per capita times population
[c] Exports plus Imports divided by GDP
[d] In thousands

Table 2. Pearson Correlation Matrix (N=3946)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	1.000									
(2)	0.981	1.000								
(3)	-0.017	0.051	1.000							
(4)	-0.029	0.081	0.538	1.000						
(5)	0.045	0.063	-0.344	0.269	1.000					
(6)	-0.017	0.080	0.534	0.980	0.261	1.000				
(7)	-0.001	0.006	0.829	-0.026	-0.587	-0.018	1.000			
(8)	0.036	0.110	0.857	0.666	-0.110	0.659	0.575	**1.000**		
(9)	0.037	0.109	0.853	0.662	-0.112	0.656	0.572	**0.999**	**1.000**	
(10)	0.036	0.112	0.865	0.671	-0.101	0.665	0.581	**0.998**	**0.996**	**1.000**

(1) Real GDP
(2) Real GDP per capita
(3) Real GDP growth rate
(4) Real GDP per capita growth rate
(5) Openness
(6) Real GDP per worker
(7) Population
(8) Overall variety
(9) Unrelated variety
(10) Related variety

Table 5. Dependent Variable: Real GDP growth rate Unrestricted Model. Least Square Within Regressions[a]

	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Real GDP (log)	-0.095***	-0.095***	-0.095***	-0.094***	-0.094***	-0.092***	-0.090***	-0.088***	-0.086***	-0.089***
	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]
Openness	0.031***	0.031***	0.031***	0.031***	0.031***	0.030***	0.030***	0.029***	0.029***	0.029***
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]
Rel. var. (logs)	0.044***	0.044***	0.044***	0.044***	0.044***	0.044***	0.045***	0.046***	0.047***	0.045***
	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]
Unr. var. (logs)	-0.031**	-0.031**	-0.031**	-0.031**	-0.031**	-0.032**	-0.032**	-0.033**	-0.034**	-0.032**
	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.014]
t - 1	-0.011	-0.011	-0.011	-0.011	-0.011	-0.01	-0.01	-0.01	-0.01	-0.019***
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.006]
t – 2	-0.019**	-0.019***	-0.019***	-0.020***	-0.020***	-0.020***	-0.020***	-0.020***	-0.012**	
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.006]	
t – 3	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.010*		
	[0.008]	[0.008]	[0.008]	[0.007]	[0.007]	[0.007]	[0.007]	[0.006]		
t – 4	0.003	0.003	0.003	0.003	0.003	0.003	0.008			
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.006]			
t – 5	-0.001	-0.001	-0.001	-0.001	-0.001	0.006				
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.006]				
t – 6	0.008	0.008	0.008	0.008	0.009					
	[0.007]	[0.007]	[0.007]	[0.007]	[0.006]					
t – 7	-0.002	-0.002	-0.002	0.001						
	[0.007]	[0.007]	[0.007]	[0.006]						
t – 8	-0.001	0.000	0.004							
	[0.007]	[0.007]	[0.006]							
t – 9	0.008	0.004								
	[0.006]	[0.005]								
t – 10	-0.003									
	[0.004]									
Constant	1.711***	1.714***	1.707***	1.703***	1.702***	1.691***	1.684***	1.673***	1.661***	1.682***
	[0.185]	[0.185]	[0.184]	[0.184]	[0.184]	[0.184]	[0.184]	[0.184]	[0.184]	[0.183]
Observations	2846	2846	2846	2846	2846	2846	2846	2846	2846	2846
Adjusted R^2	0.04904	0.04916	0.04924	0.04978	0.04943	0.04929	0.04924	0.04894	0.04833	0.04721
Akaike IC	-8203.2	-8204.5	-8205.7	-8207.2	-8209.2	-8208.6	-8209.4	-8209.5	-8208.6	-8206.2
Bayesian IC	-7947.2	-7954.4	-7961.6	-7969.0	-7977.0	-7982.4	-7989.2	-7995.2	-8000.2	-8003.8

[a] See previous table footnotes. Real GDP per worker and population also included but not reported, due to lack of significance.

Table 6. Dependent Variable: Real GDP growth rate Unrestricted Model. Least Square Within Regressions[a]

	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Real GDP (log)	-0.094***	-0.094***	-0.094***	-0.094***	-0.093***	-0.092***	-0.090***	-0.089***	-0.086***	-0.089***
	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]
Openness	0.031***	0.031***	0.031***	0.031***	0.030***	0.030***	0.030***	0.029***	0.029***	0.029***
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]
Unr. var. (logs)	-0.046***	-0.046***	-0.046***	-0.046***	-0.046***	-0.046***	-0.047***	-0.047***	-0.049***	-0.047***
	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]
Rel. var. (logs)	0.059***	0.059***	0.059***	0.059***	0.058***	0.058***	0.059***	0.060***	0.061***	0.059***
	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]
t - 1	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.018***
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.005]
t – 2	-0.020***	-0.020***	-0.020***	-0.020***	-0.020***	-0.020***	-0.020***	-0.020***	-0.011**	
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.005]	
t – 3	0.008	0.008	0.007	0.007	0.007	0.007	0.007	0.011**		
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.005]		
t – 4	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.004			
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.005]			
t – 5	0.000	0.000	0.000	0.000	0.000	0.006				
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.005]				
t – 6	0.003	0.003	0.003	0.003	0.007					
	[0.006]	[0.006]	[0.006]	[0.006]	[0.005]					
t – 7	0.005	0.005	0.004	0.005						
	[0.006]	[0.006]	[0.006]	[0.005]						
t – 8	-0.003	-0.003	0.001							
	[0.006]	[0.006]	[0.005]							
t – 9	0.006	0.005								
	[0.006]	[0.004]								
t – 10	-0.002									
	[0.003]									
Constant	1.711***	1.713***	1.702***	1.700***	1.690***	1.680***	1.672***	1.664***	1.647***	1.672***
	[0.185]	[0.185]	[0.185]	[0.184]	[0.184]	[0.184]	[0.184]	[0.184]	[0.184]	[0.184]
Observations	2846	2846	2846	2846	2846	2846	2846	2846	2846	2846
Adjusted R^2	0.05022	0.05050	0.05044	0.05078	0.05075	0.05032	0.05020	0.05032	0.04902	0.04772
Akaike IC	-8206.7	-8208.5	-8209.3	-8211.2	-8212.1	-8211.7	-8212.3	-8213.6	-8210.7	-8207.7
Bayesian IC	-7950.7	-7958.4	-7965.2	-7973.1	-7979.9	-7985.5	-7992.0	-7999.3	-8002.3	-8005.3

[a] See previous table footnotes. Real GDP per worker and population also included but not reported, due to lack of significance.